Effect of Intensive Management Practices

on Wheat Yields and Profitability in Missouri

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Considerable interest in improving wheat yields and profitability has been shown throughout the U.S. over the past ten years. Much of this interest has resulted from the dramatic yield increases achieved by English producers during that time - an annual increase of 5.0 bushel/acre per year (Figure 1). During that same time period, wheat producers in the U.S. have shown a much lower rate of increase in wheat yields - 1.02 bushel/acre per year (Figure 2). Missouri growers have been no exception to that - 0.4 bushel/acre per year (Figure 3).

Regardless of the environmental constraints placed upon wheat production in many wheat production areas within the U.S., growers have asked for research results on the techniques which produced the dramatic yield increases observed in England and some other European countries. That interest by producers in nearly every wheat growing state in the U.S. has spawned research on those cultural practices which have proven to be useful in Europe.

METHODS

Studies were begun in Missouri in 1984 to determine the effect of spring sequential nitrogen, fungicide, and growth regulator applications on wheat yields and profitability. Some sites were not planted or did not survive due to environmental conditions in certain years. Those environments in which harvestable information was attained are listed in Table 1.

Table 1. Sites and years in which intensive wheat management research was conducted in Missouri.

Location	State Region	Time Period Harvest Years
Columbia	Central	1984 - 1985
Mt. Vernon	Southwest	1984 - 1987
Portageville	Southeast	1985 - 1987

Two cultivars, Pike and Pioneer 2550, were planted the first three years of the study. Hybrex HW 3015, a soft wheat hybrid, was added the second year and was included thereafter. Caldwell and Pioneer 2551 replaced Pike and Pioneer 2550, respectively, for the last year of the study.

FIGURE 1. WHEAT YIELDS IN ENGLAND (1975 - 1984)

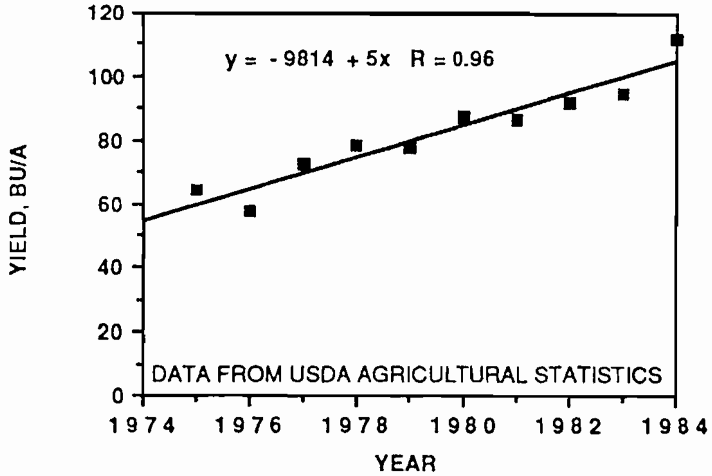


FIGURE 2. UNITED STATES WHEAT YIELDS (1975 - 1984)

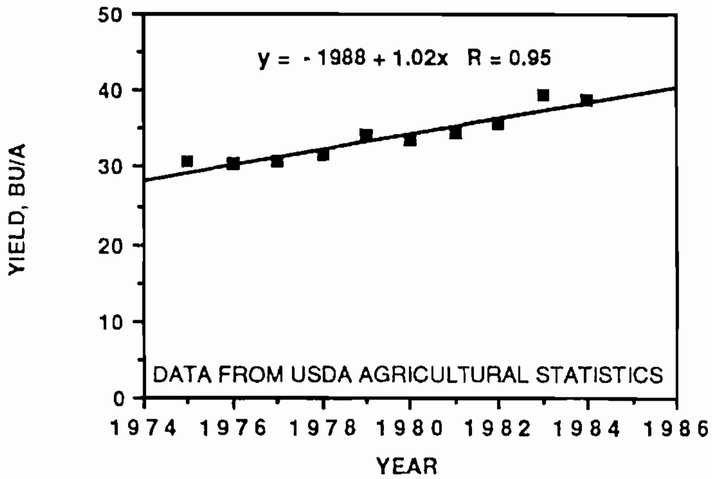
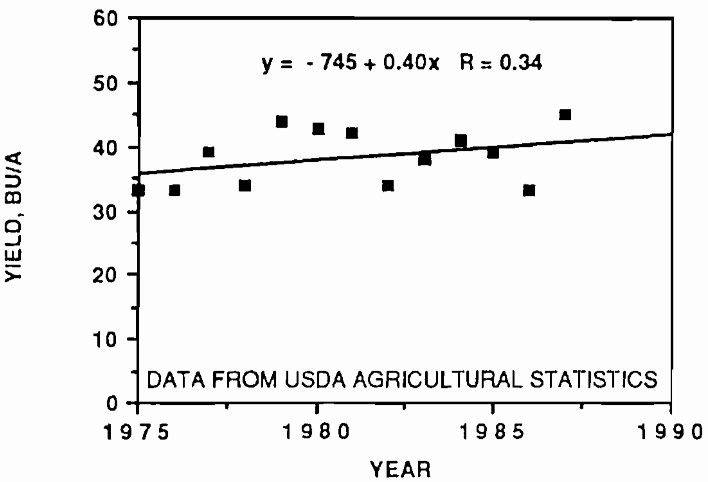


FIGURE 3. MISSOURI WHEAT YIELDS (1975 - 1987)



Treatments are listed in Table 2 and were chosen to determine the amount and timing of spring nitrogen applications necessary to achieve maximum yields and profitability. In addition, fungicide and growth regulator applications were designed to determine their effect under a rather intensive nitrogen management regime. Treatment 8 was added after the first year of the study in an attempt to discover whether the spring nitrogen application needed to be split and applied sequentially in order to achieve maximum yields.

Table 2. Intensive wheat management treatments used in Missouri studies.

Treatment No.	Spring Nitrogen (lb/a)	Feeke's Growth Stage	Growth Regulator	Fungicide
1	0	-	+	+
2	40	3	+	+
3	40 + 40	3 + 7	+	+
4	40+40+40	3+7+10.5	+	+
5	40 + 40	3 + 7	+	-
6	40 + 40	3 + 7	-	+
7	40 + 40	3 + 7	-	-
8	80	3	+	+

All treatments received 80 lbs/a nitrogen in the fall in 1984. In succeeding years, 40 lbs/a N was broadcast on all treatments. Urea was the form of nitrogen chosen for the fall application while ammonium nitrate was used for all spring nitrogen applications. The growth regulator, Cerone, was used throughout the study and was applied at Feeke's growth stage 9. It was not applied at Portageville in 1985 due to excessive rainfall at and after the recommended application time. In 1984, Bayleton and mancozeb (Dithane M-45) were applied in two applications at Feeke's stage 9 and 10.5. Tilt was used from 1985 onward and one application was made at Feeke's stage 9.

All plots were planted at approximately 2 bu/a seeding rate (1.5 million seeds/acre) with a drill of 7 inch row spacing. Plot size was 10 ft. by 30 ft. in most cases. Harvesting was accomplished by a plot combine with the exception of Columbia in 1984 where conditions required hand harvesting.

Yield, heads/m^2, 1000 seed weight, test weight, and moisture content were measured. The number of seeds/head was calculated from the other yield components. Lodging was recorded according to the Belgian Lodging scale (Oplinger et al.) where observed. Disease ratings were made according to James (1971) but are not reported here.

RESULTS AND DISCUSSION

Year-to-year variation in yields can be explained partly by climatic differences. Yield levels of the best treatments ranged from 50 bu/a to over 85 bu/a in different environments. Often, it appeared that wheat yields were enhanced by warm spring temperatures which resulted in desirable conditions during floret development and helped prolong the grain filling period. As an example, the length of the grain filling period was only 30 days at Columbia in 1984 while it lasted for 42 days in 1985. Flowering date began on May 30 in 1984 while warm spring temperatures resulted in flowering on May 11 in 1985. Possibly as a result, the highest yield achieved in any treatment for 1984 was 65 bu/a while in 1985 Treatment 3 averaged 85 bu/a. Results shown in Table 3 are averages for all cultivars and nine environments except for Treatment 8 which was averaged over 7 environments.

Table 3. Agronomic results of Intensive Wheat Management research in Missouri.

Trt. No.	Yield (bu/a)	Heads/ m^2	Seed Weight g/1000	Seeds/ Head	Test Weight (lb/bu)	Height (In.)	Lodging[1]
1	47.9	579	29.5	19.9	56.2	31.4	0.6
2	58.6	662	29.0	22.0	56.0	33.7	1.1
3	63.7	705	27.6	23.0	55.3	34.7	2.2
4	63.3	709	28.1	22.3	55.9	34.3	2.8
5	57.7	710	25.9	21.8	54.4	34.3	2.5
6	62.0	704	27.3	23.1	54.8	37.3	3.6
7	55.6	717	25.9	21.4	53.7	37.4	4.1
8[3]	61.3	691	28.1	22.4	54.9	34.5	2.5
LSD .05	1.7	26	0.49	1.0	0.4	0.4	0.34

[1] 0.2 - whole plot erect; 9.0 - whole plot lodged completely flat
[3] Treatment 8 was not included in 1984;

Yield responses to increasing nitrogen rates were evident to a total of 80 lb N spring applied nitrogen whether applied once or in two sequential applications. Any of the spring nitrogen treatments resulted in an increase in effective tillers (heads) compared to the control treatment without spring nitrogen. The number of heads in these studies would indicate that we had sufficient tillering for maximum yields.

Head size (seeds/head) was calculated from the other yield components and reveals heads which are apparently too small to achieve the yield potential of wheat in Europe. However, head samples were taken from all plots and spikelet and seed numbers are being determined for those samples at this time. Although those analyses have not been completed, preliminary results would indicate that counted seed numbers are considerably higher than those which are calculated. Consequently, little assurance can be placed on the reliability of the analyses of these results for that yield component.

Seed weights appeared to follow a pattern throughout the research. While added nitrogen reduced seed weights (Trt 3 vs Trt 1, Table 3) it was likely a result of increased tiller numbers and head size for the treatment with higher nitrogen. Treatments with fewer, smaller heads result in seeds with fewer competitors. Consequently, they appear to have filled to a larger size. Nitrogen applied at heading (Trt 4) resulted in higher seed weights - an indication that nitrogen might be limiting seed size slightly during the grain filling period. That treatment also resulted in a significant increase in test weight - not a yield component but still an important grading factor. Fungicide applications were also able to increase both seed weights and test weight.

The growth regulator - Cerone - was not able to increase yields in these studies, but it did not reduce yields, either. It was quite effective in reducing both plant height and lodging. We determined that any plots which received a lodging rating greater than 3.5 were "unacceptable". Using that criterion, Cerone was able to control lodging and keep the crop standing in an "acceptable" manner in instances where its absence resulted in plots which were nearly flat. No effort was made to determine the time required to harvest these plots, but Cerone treated plots were nearly always much easier and faster to harvest.

Yield analyses of these data give only one picture of the worthiness of some of these management practices. Economic analyses can give a more complete picture of the potential usefulness of these products or techniques. However, it is imperative that the reader notes that one economic analyses is merely a "snapshot" in time and will change rapidly with changing crop, chemical or fertilizer prices. In addition, although not shown in this written report, the effect of the U.S. government farm program cannot be overlooked in its effect on the profitability of wheat production. However, we will make an attempt to analyze the research results from this 4 year study and show how the average yields obtained for specific treatments affect its profitability and likelihood of application.

Costs ascribed to specific treatments are shown at the bottom of Table 4. The variable costs shown are those considered necessary to produce a wheat crop using the lowest custom rate in the University of Missouri Custom Rates Guide for preparing ground, planting, and harvesting. The net return should be described as the amount left to be applied to land, labor, capital, and management. This is not profit, but is often referred to as such. Federal payments for participation in the farm program are not included in Table 4.

The marginal increase in net return (MINR) is defined as the change in the net return which can be attributed to the practice just applied (Perrin et al.):

e.g. MINR = Net Return (Trt 2) - Net Return (Trt 1)
= $47.50 - $32.75
= $14.75

In each case the MINR is calculated using the treatment applied just previously as the base treatment. As in the example just shown, the application of the first increment of spring nitrogen resulted in an increase in net return of $14.75. A subsequent application of nitrogen resulted in a MINR of only $0.75 even though there was a statistically significant yield increase of 5.1 bu/a.

The marginal rate of return (MRR) is the rate of return on any additional money invested (Perrin et al.) and is calculated by dividing the MINR by the additional cost incurred in achieving the MINR. Consequently, no MRR can be calculated for the "base" or first treatment of a comparison or group of comparisons.

e.g. MRR = MINR / [Variable costs (Trt 2) - Variable costs (Trt 1)]
= $14.75 / [$99 - $87]
= $14.75 / $12
= 1.23
= 123% (listed as percent)

Table 4. Economic analyses/acre of Intensive Wheat Management research in Missouri.

Trt. No.	Yield (bu/a)	Variable Costs	Gross Return	Net Return	Marginal Increase in Net Return	Marginal Rate of Return
1	47.9	$ 87	$119.75	$32.75	---	---
2	58.6	$ 99	$146.50	$47.50	$14.75	123%
3	63.7	$111	$159.25	$48.25	$ 0.75	6%
4	63.3	$123	$158.25	$35.25	-$13.00	-108%
8	61.3	$107	$153.25	$46.25	---	---
3	63.4	$111	$158.50	$47.50	$ 1.25	31%
- Fung	56.7	$ 92	$141.75	$49.75	---	---
+ Fung	62.9	$106	$157.25	$51.25	$ 1.50	11%
- Cerone	60.3	$ 96	$150.75	$54.75	---	---
+ Cerone	62.5	$106	$156.25	$50.25	-$ 4.50	- 45%

Wheat Price = $2.50/bu; Nitrogen cost = $0.20/lb N; Fungicide cost = $10.00/A; Cerone cost = $6.00/A; All applications cost $4.00/A.

Although most farmers would like to receive an additional $2.00 in return for the investment of $1.00 (MRR = 200%), economists recommend that farmers should continue to invest money only as long as MRR's exceed the potential return from some safer investment by a significant amount. Perrin et al. recommend that if you as a farmer could get 10% return on money invested in your local bank, then you need a MRR in excess of 40% in order to invest that money in your farming operation. If the practice is very risky, the MRR recommended is 50% or more. If you are borrowing money for the input item in question, then your MRR should be 20% above the effective loan rate for average risk and 30% for investments with considerable risk.

In the examples from our research data, the use of a fungicide would return 11% on invested money (and in about 2 months). However, many farmers are reluctant to invest a significant amount of money ($14.00) to return $1.50.

Most are more likely to accept a lower MRR for an input item that would only cost them a few dollars per acre (as in a case of an additional 20 lbs N/a which would only cost $4.00). Keep in mind that an increase in crop price to $3.00/bu will change the situation. In that event, the MRR for fungicide use would increase to 33% and would make the practice much more attractive. Wheat seed producers might find fungicide applications very attractive since they get higher prices for their product and the research results show an increase in seed weight and test weight - a bonus when advertising their product to other farmers. In any event, all treatments with negative MRR's are practices to avoid.

Economic analyses in Table 4 indicate that a barely significant yield response to splitting 80 lb spring applied N into two applications returns 31% on the additional investment of an application. However, one must remember that the additional 40 lbs N applied as a sequential only returned 6% over a lower rate of spring applied N (40 lb total N in the spring). That is even though there was a significant 5.1 bu/a yield increase from the added nitrogen. Reducing the cost of nitrogen to $0.15/lb N would increase the net return and the MRR would jump from 6% to 27.5%.

As you can see, the results shown in Table 4 are only a "snapshot" in time and changes in crop prices or input costs can change the results dramatically. It is important to know that before one can begin to determine his MINR or MRR, he must know how his crop is going to respond to the additional management practice which he plans to incorporate.

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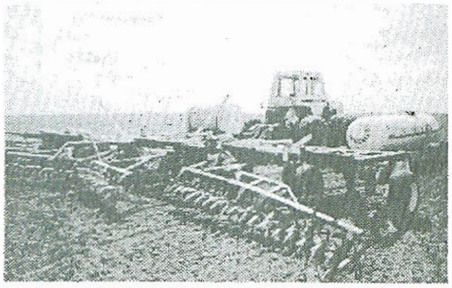

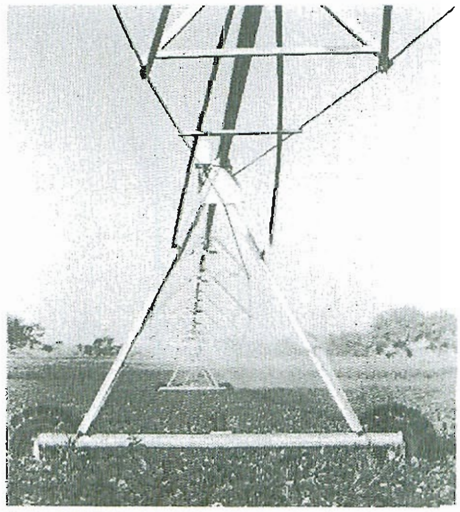
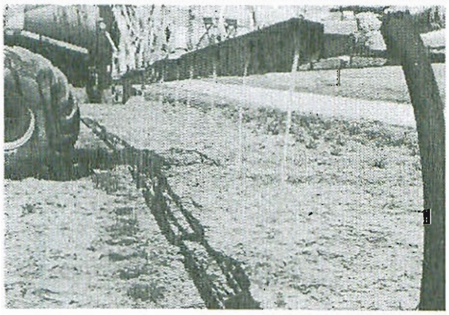
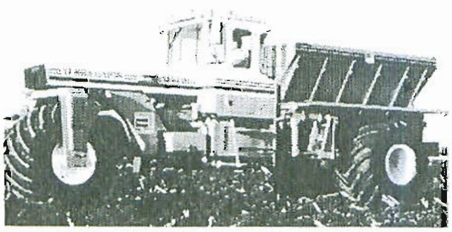

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